* LIST OF THE REFERENCES

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(Including English Translation)

ORACLE9I DATABASE SUMMARY

An Oracle White Paper
May 2002

ORACLE

Oracle9*i* Database

Purpose

This paper provides an overview of the functionality of the Oracle9*i* Database, for Information Technology professionals who are unfamiliar with Oracle.

Overall

In order to survive and remain competitive, today's organizations must focus on

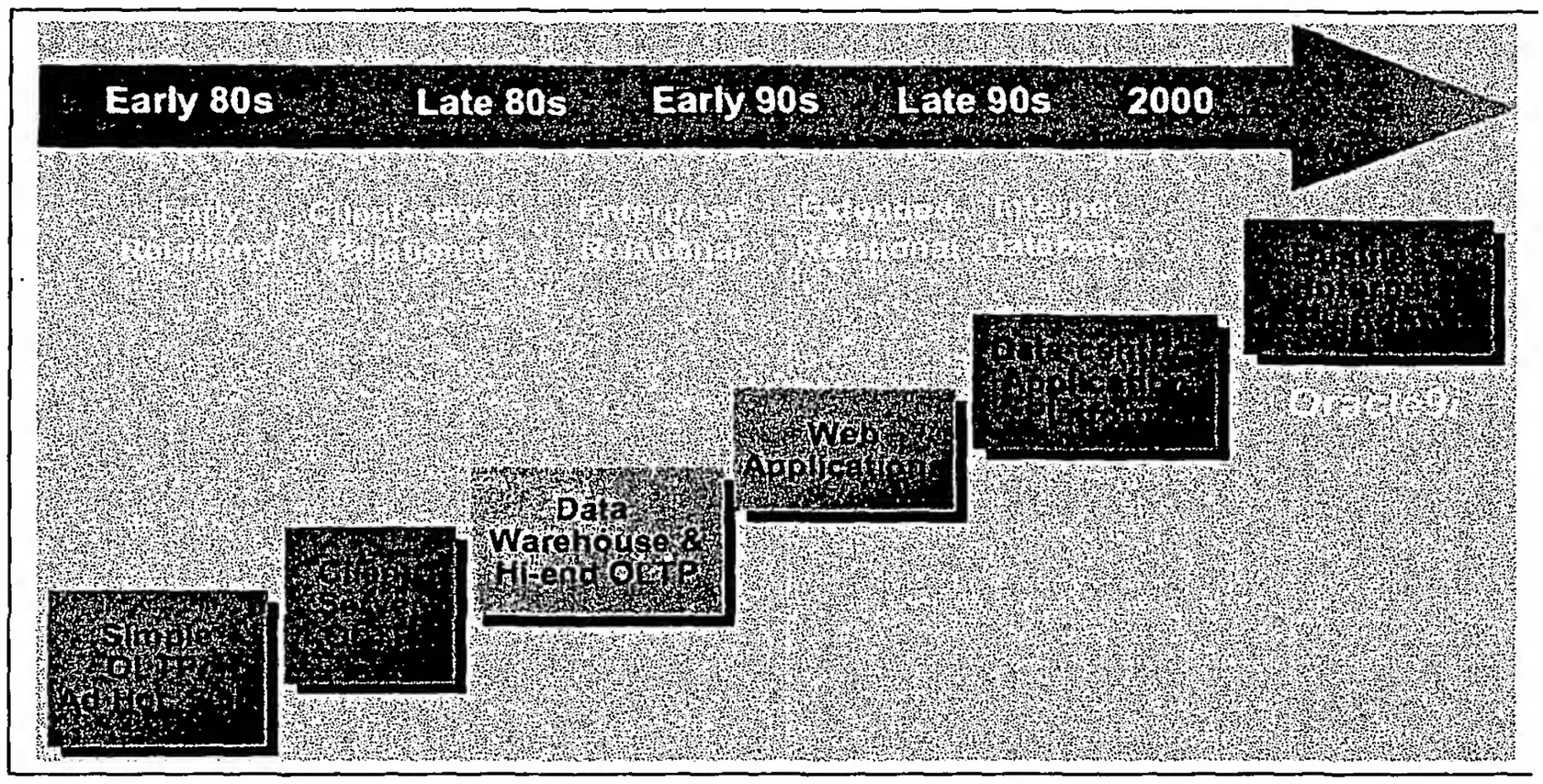
- Improving their efficiency and productivity
- Better understanding their business, their customers and their partners
- Seizing new opportunities and enabling change

Information is the most valuable asset a modern business has at its disposal in its effort to drive competitiveness. Organizations that can effectively use their business information are the ones most likely to profit and survive in today's tough economic climate- and how effectively an organization can use its information depends on what it has at the heart of its information infrastructure. Data is just bits and bytes on a file system - and only a database can turn the bits and bytes of data into business information. The Oracle9*i* Database Release 2 is the current release of Oracle's information management solution - built on over 20 years experience of providing industry-leading solutions that allow organizations to efficiently store, manage, integrate and use business information.

The advent of the Internet sees entire organizations being integrated and streamlined, with the potential result of bringing hundreds of thousands of users online - employees, business partners, customers, and suppliers - to access and share the latest information. These new environments create new requirements in terms of scalability, performance and availability of data that go beyond the needs of more traditional applications.

As corporations bring more business processes online, databases and other IT components are under increasing pressure to keep those processes rolling around the clock. Since businesses rely on the availability of critical applications and information, when these break, so does the business. In the Internet age, people expect to be able to access information at any time and from anywhere. A sales representative traveling to see a customer may want to check the prices and discounts currently in effect for that customer. Or a Vice President of Operations may want to check inventory levels, to ensure that the company is maintaining enough on-hand stock to supply its customers' needs. Or a customer may want to check the status of an order they placed with your company, so they know when to expect their shipment. In a global company, people working in Asia need to be able to enter and update data for these types of applications during their workday, which would be the middle of the night at a North American data center. It is imperative that your system be up and able to service them even in the middle of the night.

To satisfy these requirements, the Oracle9*i* Database is designed to support and leverage the capabilities of the Internet. It provides extensive functionality to support businesses running on the World Wide Web, as well as traditional mission critical OLTP and Data Warehousing applications. It supports the high scalability requirements of the most demanding Internet-based and traditional mission-critical applications, as well as the highest availability requirements. It is capable of handling all types of information for all types of applications and provides outstanding, across-the-board, and transparent scalability from low-end uni-processor to high-end symmetric multi-processor systems and multi-node clustered configurations.



The Oracle9*i* Database has evolved over more than 20 years, from the earliest relational database providing ad hoc SQL, through to the Internet era, supporting Internet business applications. It has been designed to provide the most complete and low cost solution for any business information management requirement, and is the only solution available today that can

- Guarantee that critical business information is available when needed.
- Provide proven performance, scalability, and capacity on demand for any business requirement.
- Secure and protect the privacy of sensitive business information.
- Integrate business information from disparate sources, including third-party databases and file systems.
- Consolidate and manage all your Internet content
- Reduce the time it takes for a business to make better business decisions by analyzing more data faster.
- Enable an organization to develop and deploy business solutions quickly.
- Provide all these benefits yet be easy and cost-effective to manage

We explore these features in more detail in the following sections.

High Availability

Guarantee that critical business information is available when needed.

Online, immediate access to information is vital to the success of the modern business. Unfortunately, many things can occur that may cause business information to become unavailable for extended periods of time, or even be permanently lost. The Oracle Database is the only database with a comprehensive solution to protect a business from all causes of data loss - both temporary and permanent. Oracle9*i* Data Guard provides complete protection from situations that can cause data loss - protecting not only against natural disasters, but also providing the same level of protection against software corruption, human error, program malfunction and viruses by delaying the application of changes sent to the standby database site. But unlike other, more costly solutions, the Oracle9*i* Database also provides additional built-in protection against the leading cause of data loss - Human Error - by allowing any user to immediately go 'back in time' to access and bring forward previous versions of business information that may have been erroneously changed or deleted, for example using the Flashback Query feature.

Oracle's availability architecture provides fast recovery from faults, allows routine maintenance to be performed online, includes an array of system management tools to prevent and detect disruptions, and supports disaster planning solutions to protect from catastrophic events. With Oracle9*i* and the Internet, data is accessible everywhere, at any time.

Industry Leading Data Protection Environment

Oracle provides industry-leading protection against system outages and other types of unplanned downtime. After an outage of any kind, your key thought is how can I make data available and get applications working again as fast as possible? Oracle provides unique features to provide the fastest possible restart after a system goes down. After a system failure, whether due to a hardware crash, power outage, etc., Oracle provides rapid database recovery using Fast Start Fault Recovery. This functionality optimizes the time it takes to re-start the system after any outage, *regardless of the transactional activity on the system at the time of the failure!*

Oracle always guarantees that any uncommitted transactions at the time of failure will be rolled back on restart. But Oracle minimizes the effect this can have on availability by making the database available to users while the rollback of active transactions is going on. So, if a long running batch update needs to be rolled back after a system failure, instead of all users having to wait for the system to become available for work after all that activity has been rolled forward and then rolled back, Oracle provides the unique ability to open the database for work after the roll forward phase of recovery is completed. Then, the rollback of any active transactions can occur in the background, while the database is open and available for work. In the event a new transaction finds itself blocked by a dead transaction that needs to be rolled back (before the system recovery process rolls it back), Oracle can rollback the row (or rows) the transaction needs, and complete the new transaction. The rest of the recovery operation then continues in the background, while new work goes on. The key point is that the system (and data) is available for work much sooner than it would be on any other database system.

In the area of media recovery, Oracle provides parallel online backup capability, but it also provides parallel online *recovery* capability. This means that the database can be open for work while a recovery operation is occurring to fix a media failure. All the other data files and their corresponding data are available for access while the recovery operation is running.

Oracle provides many features for data protection, such as a standby copy of the primary database. The standby database provides significant functionality for disaster recovery, as well as a framework for monitoring, automation and control. Many of the tasks associated with managing a standby database are automated, including initial creation, fail over, and graceful primary-to-secondary switchover and switch back. Administrators can also optionally specify the log apply delay by which each standby site lags the production environment (for increased protection from human errors or corruption), and choose a zero data loss mode in which online redo log data is synchronously sent to the standby site.

Oracle Data Guard allows you to implement a Redo-apply (physical) or a SQL-apply (logical) standby database. Either one can be used for disaster recovery, as well as for reporting purposes. The standby configuration provides a secondary site, some distance from the primary, that has the same data as the production database, so in the event of a disaster at the main site, business can continue using the data at the standby site. The physical standby database is an image copy of the production database, and is updated by the application of the transaction entries created at the production site. As updates occur on the production site, the transaction entries are sent over to the second site where they are continuously applied, thereby keeping the standby site up to date with the main site. Upon failure of the production site, the physical standby is brought up to date with the most current information from the production database, and then it becomes the new production site.

Another alternative is to maintain a **logical** replica of the production database. This site is updated by applying regenerated SQL statements based on changes made to the primary site. In contrast, a physical standby database applies the log files from the primary site using media recovery. One benefit of the SQL apply or logical standby approach is that changes from the Primary database can be applied concurrently with end user read-only access, thus reducing possible down time even further. Also, since the logical standby site is just a logical replica of the main site, it can be defined with different schema definitions, different indexes, and so on. It can, for instance, be a subset of the data maintained on the production site.

A standby configuration is a collection of loosely connected systems, consisting of a single Primary database and a number of Standby databases, which can be a mix of both Physical and Logical Standby databases. The databases in this configuration can be in the same data center (LAN attached) or geographically dispersed (over a WAN) and connected by Oracle Network Services.

Using a combination of the redo apply and SQL apply technologies of the Data Guard capability, helps make your database resilient to data corruptions and user errors, and leverages the fail over site for reporting, backups and maintenance.

LogMiner is a tool to provide comprehensive SQL based analysis of the Oracle transaction logs which allows past transaction activity to be monitored and analyzed. It can be very useful for auditing past activity, or for resolving an application or user

error that updated data erroneously. Log Miner supports queries on the logs based on the content of the change (for example, show all changes to employee 'Smith'). A graphical user interface as well as other database features make the product easier to both learn and use.

For multi-node systems, Oracle9*i* provides much faster failure detection and reconfiguration for Real Application Clusters, reducing downtime due to a system fault. Oracle9*i* Real Application Clusters provide the highest possible availability with redundant nodes ready to take over the processing of any failed node. Oracle9*i* Real Application Clusters let you migrate all types of business applications – OLTP, DSS, Internet – to highly scalable and highly available clustered configurations without rewriting a line of code. By making clustering so accessible, the Oracle9*i* Database provides all organizations, no matter how sophisticated their technology capabilities, the ability to significantly reduce the impact of unplanned system outages on their business.

Online Data Evolution

Oracle9*i* provides a powerful online reorganization and redefinition architecture. Administrators can perform a variety of online operations to table definitions, including online reorganization of tables and indexes. Essentially, Oracle9*i* allows an online "create table as select" operation. These operations can execute *without taking the underlying data object out of service.* So applications continue to run while the schema change is taking place.

In this architecture the contents of the table are copied into a new table. While the contents are being copied, the updates to the original table are tracked by the database. After the copy completes, the updates are applied to the new table. Once the updates are applied, indexes can be created on the new table. After the indexes are created, any additional updates are applied and the result table replaces the original table. The table is only locked momentarily at the beginning and end of the operation, when the dictionary data is updated.

Any physical attribute of the table can be changed online. The table can be moved to a new location, partitioned, or be converted from one organization (e.g. heap) to another (e.g. index organized). Additionally, many logical attributes can be changed. Column names, types, and sizes can be changed. Columns can be added, deleted, renamed or merged.

Oracle9*i* also supports online create, rebuild, etc. of indexes. Indexes can be created online and analyzed at the same time. Again, this means the base table is in full service for normal transactional activity while the index operation is taking place.

Dynamic Tuning

The various memory structures used by the Oracle database can be resized dynamically, meaning no shutdown and restart of the system is necessary. So the administrator can quickly and easily address possible performance issues on the system by re-allocating memory for optimal use and throughput.

Precision Database Repair

Oracle9*i* includes prevention and improved handling of disk corruption. Should a block corruption need to be repaired via media recovery, a block media recovery feature allows recovery of only the corrupt blocks while the remainder of the table is

online. Oracle9*i* is able to restore the database to a consistent state after log corruption is detected during recovery. LogMiner allows redo entries after the corruption point to be retrieved and applied. Trial recovery allows recovery to proceed after a corrupted database block is detected so that the administrator can determine if the corruption is an isolated event. If more corruption is found, the recovery can be backed out.

Oracle9*i* can also recover from crashes quickly using a recovery algorithm that ensures that only the blocks that need be processed are read from and written to the data files. A time-based mean time to recover (MTTR) parameter also makes it much easier to set a limit on crash recovery time. Recovery Manager backup and restore operations can restart where they left off after a failure. Oracle9*i* also includes diagnostic features to quickly capture the state of a failed instance and allow diagnostics after recovery on the failed state.

Oracle also offers Oracle Fail Safe for Windows running on Windows 2000 multi-node clusters. This allows for configurations where multiple databases on multiple nodes share a common backup node, reducing the cost of providing redundancy to multiple applications.

Self Service Error Correction

Oracle9*i* contains very powerful techniques for handling human errors. Oracle9*i* empowers end users to correct their own mistakes in a much more precise, efficient, and easy manner. To correct errors, end-users need to be able to identify the error by viewing change history, and they need to be able to back out the error by restoring data as it existed before the error. Oracle9*i* provides both these capabilities. These capabilities are available at the SQL level so that applications can invoke them as any other normal SQL operation, without needing the intervention of an administrator.

The flashback query allows data to be queried from a point in time in the past. Users set the date and time that they would like to view, and then any SQL query that they execute operates on data as it existed at that point in time. This capability uses Oracle's multiversion read-consistency to restore data by applying undo as needed. Administrators can configure undo retention by simply specifying how long undo should be kept in the database. Using flashback query capabilities, a user can query the database as it existed this morning, or a few hours ago. The speed of this operation depends only on the amount of data being queried and the number of changes to the data that need to be backed out.

Using LogMiner, the transaction change history of a database can be queried from the logs. LogMiner allows content-based data filtering. For example, administrators can query just the changes to the customer John Smith. This capability enables change history to be queried at the row level. Since Redo and Undo are already maintained by the database for internal consistency, enabling these capabilities adds no overhead.

Scalability and Performance

Provide proven scalability, performance and capacity on demand for any business requirement.

Modern organizations need to support ever-increasing numbers of users demanding access to more and more business information. The same organizations also need to be able to provide low cost additional capacity on demand to meet rapidly changing market conditions. The Internet requires the highest possible scalability of applications. As more and more companies turn to the Internet to handle their everyday business processes, it becomes more important than ever that their IT infrastructure handle an ever-increasing load. For example, many companies are cutting costs and streamlining business processes by using Internet based self-service applications, such as customer service problem reporting. Customers can enter problem reports online, at any time of day or night, and search a knowledge base for fast solution to their problem. That way they can get much quicker problem resolution, with less need to incur the time delay, expense and overhead of talking to a customer service representative. Once the customer service application is in place, this is a much more cost effective way to handle customer service than the traditional approach, which has high overhead and is time consuming for the customer. This type of intra-net usage is growing at a tremendous rate, while saving money for the company overall. This is why it is critical that your database system scale to meet all your growing requirements. The Oracle9*i* Database is the only information management solution that is proven to scale to meet all business requirements on all hardware platforms - from single and mid-range multiprocessor systems, through to large scale SMP, MPP and mainframe environments. This proven scalability unlocks the full potential of any hardware and operating system investment and ensures any organization will be able to meet all business requirements in the future. As your business grows, Oracle provides the ability to grow across platforms, across operating systems, and across clustered systems. You never have to worry that your business will outgrow your infrastructure. The Oracle9*i* Database also supports deployment of larger numbers of users more quickly than any other information management solution by providing unique concurrency features that no other database has - allowing an organization to quickly and easily scale any application, from tens to tens of thousands of online users. Oracle has many customer examples of sites running on the web with very high volumes of users and transactions.

Portability

The Oracle Database provides unique portability across all major platforms, and ensures that your applications will run without modification even after changing platforms. This is because the Oracle code base is identical across platforms, so you have identical feature functionality across all platforms, for complete application transparency. No more rewriting of applications when you have to change hardware/software platforms as you outgrow your systems! Because of this portability, Oracle does not lock you in to a single operating system; you can easily upgrade to a more powerful server as your requirements change. No need to modify your data or modify your applications because you have outgrown the system you were running on. Oracle grows with your business, seamlessly.

Oracle9*i* Real Application Clusters

Oracle9*i* Real Application Clusters enables all applications to exploit cluster database availability, scalability and performance with *no application modifications*.

Applications can treat Oracle*9i* Real Application Clusters as a single system and do not need to be modified or partitioned to achieve near-linear cluster database scalability. This allows customers to scale out the database tier as usage and demand continues to grow, without changes to the application. Furthermore, Oracle*9i* Real Application Clusters is self-tuning and adapts to the changing nature of the database workload by dynamically shifting database resources across the cluster servers for optimal performance.

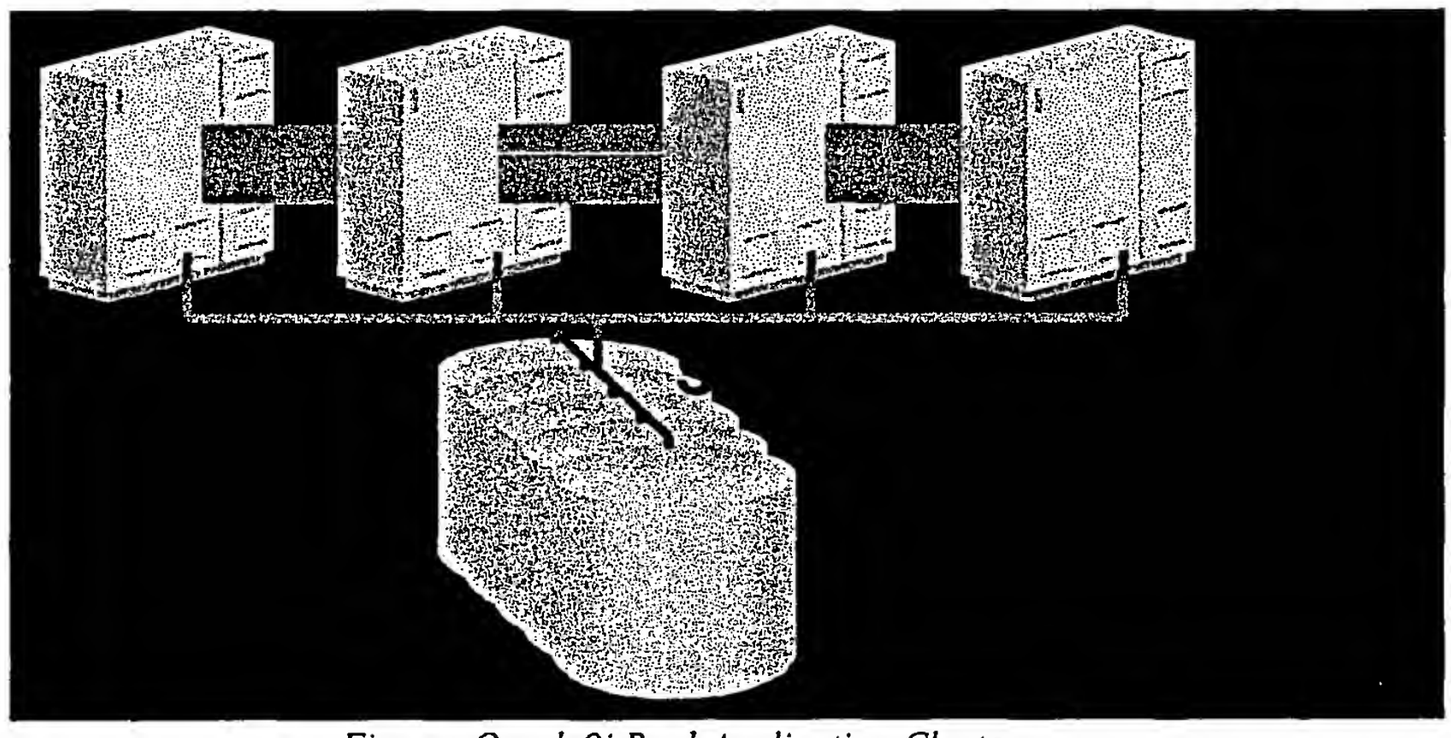


Figure: Oracle9i Real Application Clusters

In addition to the limitless scalability provided by Oracle9*i* Real Application Clusters, you also get a very comprehensive high availability solution. If any node in the cluster fails for any reason, the workload that was running on the lost node fails over to another node in the cluster. As long as any node in the cluster is alive, you can still access your data and your business continues to run. This provides maximum availability of the data, so business applications can continue to run. All of the data is always available to any node in the cluster, as needed.

With Oracle9*i* Real Application Clusters, companies can pay as they grow for their business information requirements. Real Application Clusters - breakthrough technology that is unique to Oracle - allows low-cost commodity hardware to be clustered together to provide a highly scalable but low-cost platform that supports more users online for longer, without incurring the cost and time taken to re-develop or re-deploy existing business applications. Oracle*9i* Real Application Clusters allows any organization to start small, grow quickly and immediately react to increased demand for their business services.

Multi-version concurrency

Additionally, your business needs access to accurate data. Daily business decisions are made based on accurate sales projections, parts inventories, purchases, etc. When one employee is updating information, that change does not take place until the employee submits (or commits) the request to the data server. Meanwhile, a manager running a report wants an accurate view of business information at the time the report is run. If any uncommitted information is included in the report the results are no longer accurate. Some data server products allow access to information that has been changed, but not yet committed. This is called a "dirty read". Dirty reads

can lead to the wrong information in reports and queries, which can then lead to erroneous business decisions! To get around this problem, those data servers must use read locks, meaning data that is read cannot be changed and data that is changing cannot be read. This greatly slows down throughput and concurrency on the system, since readers are blocking writers, and writers are blocking readers. This limiting of concurrency is the only approach they have to being sure your applications aren't receiving inaccurate data.

Oracle's unique multi-version read consistency model provides consistent and accurate results without dirty reads or blocking of reads. It is specially designed to eliminate the need for the compromise between data accuracy and concurrency on the system. All aspects of your business run concurrently and everyone is guaranteed a consistent view of information. Oracle believes that timely access to consistent and accurate business information without compromises in concurrency is a cornerstone of information management.

Non-escalating row level locking

A fundamental requirement for any transaction processing system is maintaining the integrity of the business data. When someone is updating information, the data server holds that information with a lock until the update is submitted or committed. Until that happens, no one else can make changes to the locked information. This ensures the data integrity of the system.

Some data servers, however, lock more information than required, making it unavailable for anyone else to update or, in some cases, even to query. This can cause unnecessary delays and disrupt your business's operations. Most data server products appear to provide row-level locking: they initially lock only the row being worked on. However, as system activity increases, they begin to lock more data than is necessary for maintaining transactional integrity. Because these data servers use system memory to track locking information, as the load on the system increases, these servers start locking larger sections of information in order to minimize their memory usage. Instead of just locking the row being modified, they "escalate" locks to cover entire groups of rows or pages, or sometimes even the entire data table. This lock escalation means that your users have to wait for other users to complete their work, even if they are working on different information. For example, one person updating some customer information may prevent someone else from updating a different and unrelated customer! This unnecessary contention has a direct impact on the throughput of your business. This lock escalation is particularly painful since it is most likely to occur when your system is at it's busiest

Oracle eliminates this whole problem through unique non-escalating row-level locking. Oracle always locks only the row of information being updated. Since Oracle includes the locking information with the actual rows themselves, Oracle can lock an unlimited number of rows so users can work concurrently without unnecessary delays. Oracle provides the continuous accessibility to information that is imperative to your business.

Security

Secure and protect the privacy of all business information.

The Internet (including E-commerce, VPNs, remote access etc.) is driving the requirement for server-enforced, granular access control. For example, you want to ensure that customers accessing production data over the Internet see only their own accounts, and not those of other customers (some of whom are competitors of one another). Putting all security in a web server will not solve this problem, since it is more of an issue of securing data.

Application-based security is not secure, because any other way to access the data bypasses the security; if a user needs to use an ad hoc query tool or a report writing tool, then you have no security.

Many applications have stringent requirements for privacy; e.g., medical applications must ensure that doctors can only see their own patients' records. HR applications also have very complex access control conditions and privacy concerns (e.g., employees can see their own records, managers can see records of employees who work for them but not their personal data like benefits selections). If you build this security into applications rather than in the database, you are back to the initial problem that bypassing the application means bypassing security.

Lastly, the cost of ownership is much lower if you build security *once*, in the data server, instead of implementing it in every application that accesses the data.

The fact that modern organizations can derive exceptional competitive advantage from their business information is a double-edged sword - the information that a business uses to ensure their competitiveness can also be used against them by their competitors. In addition, the push towards more and more consolidated customer information being shared with larger numbers of users dramatically increases the requirement to guarantee privacy of sensitive personal information. And as more and more users are brought online both inside and outside an organization, the ability to strongly authenticate and centrally manage a large user population is becoming paramount.

The Oracle9*i* Database is the only information management system that addresses all these requirements with one complete and integrated solution. It builds upon the expertise and assurance of 14 server security evaluations, and provides the most secure platform in the world for business information.

Providing an End-to-End Security Infrastructure

Oracle9*i* provides the most secure application development and deployment platform in the industry. Key focus areas include:

- Strong, three-tier security
- Standards-based Public Key Infrastructure (PKI)
- Deep data protection
- Improved user and security policy management
- Data encryption

- Directory services

Strong, Three-Tier Security

Perhaps the most useful security feature in Oracle*9i* for supporting three-tier environments is the ability to proxy authenticated user identity from a middle tier to the database tier. Oracle's proxy authentication feature allows a database client to set up, within a single database connection, a number of "lightweight" user sessions, each of which is associated with a different database user.

This proxy authentication includes credential proxy of X.509 certificates or Distinguished Names (DN), This provides strong, three-tier security by enabling an SSL credential — an X.509 certificate or DN — to be passed to the database for purpose of identifying (but not authenticating) the user. For example, a user can authenticate to a middle tier using SSL, the middle tier can extract the DN from the certificate and pass it (or the full certificate) to the database.

The proxy authentication also includes support for thick JDBC, connection pooling for 'application users' (thick and thin JDBC, OCI), as well as integration with Oracle Internet Directory. JDBC is an industry-standard Java interface that provides a Java standard for connecting to a relational database from a Java program. Sun Microsystems defined the JDBC standard, and Oracle Corporation, as an individual provider, implements and extends the standard with its own JDBC drivers. Oracle implements two types of JDBC drivers: Thick JDBC drivers built on Oracle's network software, and thin (pure Java) JDBC drivers to support downloadable applets.

An extensible, secure application role provides context-based role enablement. For example, a secure application role can ensure that a user can only access the database through a middle tier. The result is that user identities are maintained securely through all tiers of an application, with centralized user and privilege management in Oracle Internet Directory.

Standards-based PKI

Public Key Infrastructure (PKI) has emerged as the authentication technology most appropriate for securing Internet and e-commerce applications. Since users maintain their own certificates, and certificate authentication involves exchange of data between client and server only (i.e., no third party authentication server needs to be online), there is no limit to the number of users that can be supported using PKI. Moreover, PKI allows delegated trust. That is, a user who has obtained a certificate from a recognized and trusted certificate authority can authenticate himself to a server the very first time he connects to that server, without that user previously registering with the system.

The standards-based PKI support of Oracle Advanced Security includes support for Public Key Certificate Standard (PKCS)#12 wallets, enabling existing PKI credentials to be shared by an Oracle Wallet, thus reducing PKI deployment costs and increasing interoperability. Wallets can be downloaded from Oracle Internet Directory to support mobile or 'hot-desked' users. Oracle PKI support provides integration with Oracle Wallets, Entrust Profile, and Microsoft Certificate Store enabling organizations to integrate their existing PKI infrastructures into Oracle9*i*. In addition, Oracle encrypts all network traffic into the database using all industry

standard algorithms, including DES, 3DES, RC4 and the new Advanced Encryption Standard (AES).

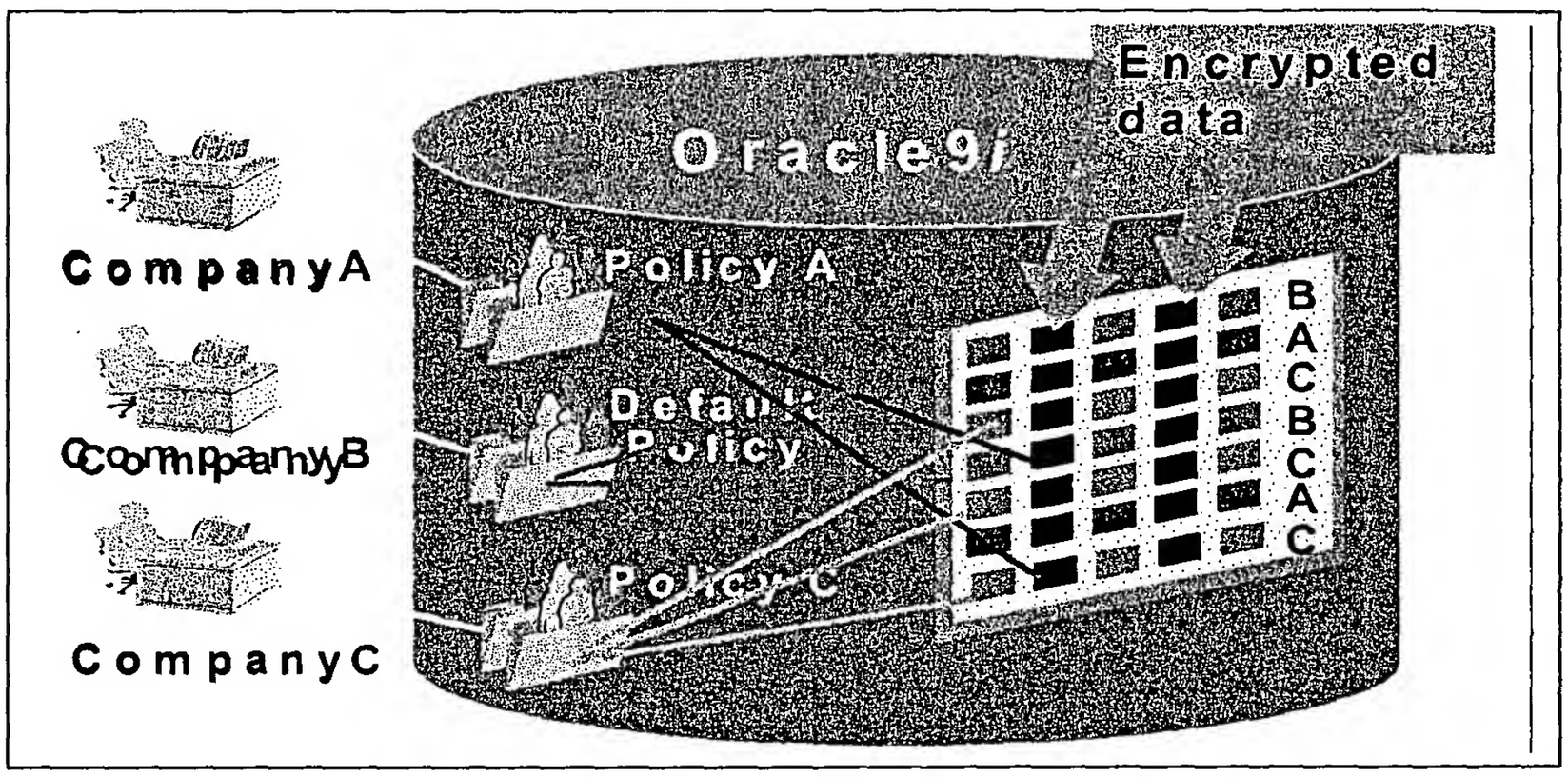


Figure: Deep Data Protection in Oracle9i

Deep Data Protection

The unique Virtual Private Database capability in the Oracle*9i* Database allows advanced security policies to be built directly into the database itself, ensuring that users can only access data relevant to their specific security realm. This means that row level security is enforced. Once this security logic has been defined in the policy on the database table, all access to that data table is limited to what is allowed by the business rule. This means that application logic no longer needs to enforce which rows and columns of a data table are seen by the application, it is automatically and transparently limited by the security policy. Gone are the days when complex security logic had to be implemented using applications and views on the table. With Oracle's Virtual Private Database implementation, the security is enforced 100% of the time; there is no way to "bypass" the security as there is with security implemented in an application. With application implementation of security rules, bypassing the application and using an ad hoc tool, (for example, SQL*Plus) means bypassing the security. Once security is enforced at the database level, application development is greatly simplified as well, since the security logic is written and maintained in one place, rather than having to be written and maintained in every single application running on the system!

Fine-grained auditing capabilities are also built into the Oracle*9i* Database, ensuring that any access to highly sensitive data can be fully and dynamically audited in real-time. Fine-grained auditing allows organizations to define audit policies, which specify the data access conditions that trigger the audit event, and use a flexible event handler to notify administrators that the triggering event has occurred. For example, an organization may allow HR clerks to access employee salary information, but audits access when salaries greater than $500K are accessed. The audit policy ("where SALARY > 500000") is applied to the EMPLOYEES table through an audit policy interface. An audit column is used to reduce the incidence of

false audits. For example, selecting all NAME and ADDRESS information will include individuals whose salary is greater than $500K; however, unless the SALARY column (that is, the audit column) is returned, no audit event is triggered.

Oracle captures the SQL text of the statement the user executed in audit tables. In conjunction with other database features such as LogMiner, fine-grained auditing can be used to recreate the records returned to a user. This may be especially important to organizations that have especially sensitive information they wish to share, for which they require strict accountability, such as intelligence or law enforcement agencies.

The event handler provides organizations with flexibility in determining how to handle a triggering audit event. A triggering audit event could be written into a special audit table for further analysis, or could activate a pager for the security administrator. The event handler allows organizations to fine-tune their audit response to appropriate levels of escalation. Fine-grained auditing can thus serve as an intrusion detection system for the database.

Improved Enterprise User Security

Superior user and security policy management is provided through Oracle Advanced Security's Enterprise User Security, including management of password-based users in Oracle Internet Directory, and password policy administration features such as password expiration and retry limits. Contexts for the Virtual Private Database can also be externalized and stored in Oracle Internet Directory for greater control and user scalability. Oracle also provides a user migration tool for enterprise users. This makes it easy to migrate database users to directory based users, to help Oracle customers reap the benefits of user centralization, which helps lower the cost of ownership and administration of the enterprise environment.

Data Encryption

As a further precaution, the Oracle9*i* Database supports programmatic column level encryption of data, preventing any highly sensitive information from being accessed by anyone other than those that have a true right to know. Oracle provides an encryption toolkit for encryption of sensitive data, such as salaries or credit card numbers. With data encryption, even someone accessing the database improperly is still unable to view or otherwise use the encrypted data, thus maximizing the security of the data.

Oracle Label Security

Oracle Label Security is a fine-grained access control product. It adds a special tag (label) to data rows, providing sophisticated and flexible row label security. It is built on the Oracle9*i* Virtual Private Database technology. Oracle Label Security is based on labeling concepts used by government and defense organizations to protect sensitive information and provide data separation. Application hosting, health care and other industries can also take advantage of data labeling to help solve security requirements in the Internet Age. For example, in application hosting, a subscriber label can be used to separate data among subscribers in the same application. Oracle Label Security is enforced within the database, providing security even if the application is bypassed. Label Security provides a dimension of access control that is not easily achieved using existing application data. Oracle Label Security also includes a sophisticated policy management tool, to manage policies, labels, and user

label authorizations. Oracle Label Security is an out-of-the-box Virtual Private Database solution.

Oracle Internet Directory

Oracle9*i* supports LDAP technology to centrally manage network naming, easing deployments whether customers have 1 or 100's of databases with tens or tens of thousands of users. The LDAP directory is one central component of Oracle's enterprise security architecture. Oracle Internet Directory is particularly well suited for this function due to its security, availability and performance, although customers can use other directories if they are adequate in these respects. Oracle9*i* directly supports Oracle Internet Directory and Microsoft Active Directory.

The directory is used to maintain roles (corresponding to groups of privileges) of users that are then defined across all servers in the enterprise. Since the naming convention used in LDAP and in X.509 certificates is the same (X.500 Distinguished Names (DNs)), it is also very well matched to Oracle's authentication and single sign-on architecture, which is based on SSL and X.509. When a user authenticates by means of SSL and an X.509 certificate, the server can extract that user's identity and DN, and then query the LDAP server using the DN to find out what roles that user has. The LDAP directory is also an ideal mechanism for managing certificates and information about them, such as whether they have been revoked. It also is usable as a staging area for wallets, which store users' encrypted certificates and associated private key data. This enables single sign-on for users who may need to move from one client PC to another, by downloading their wallets to the machine they are using for the duration of the session.

Oracle database password verifiers for password-authenticated enterprise users are natively stored and validated in Oracle Internet Directory. For custom applications, or applications whose users are not natively known to the database, user passwords can also be encrypted using either standard or custom crypto schemes. Oracle Internet Directory supports an IETF LDAP standard for representing prefixed user passwords where the prefixes identify the crypto scheme used for hashing the password values. A default hashing mechanism may be chosen from a variety of standard schemes, including MD5, SHA-1, and Unix "crypt." Values hashed by external agents may also be stored. This is useful when external authentication service agents want to use custom crypto schemes.

A web-based Oracle Internet Directory Self-Service Administration Servlet enables users to administer their own personalized data over the Web. Directory administrators can restrict the set of attributes that users are allowed to self-administer, including group memberships. Extended support for ACLs governing user self-administration of membership allows authenticated users to add their own Distinguished Names (DNs) to membership of a LDAP group object or any object type that holds membership information, including roles and proprietary subscriber lists.

Certification with certain limited Oracle9*i* Real Application Clusters configurations improves availability both for the front end, where the LDAP directory service as well as replication processes reside, and the back end Oracle RDBMS, where the directory data is stored. Support for "logical hosts" in clusters allows fail-over to a different physical host within the same cluster and also transparently supports continued availability of directory replication.

Data Integration

An important feature of any database management system is the ability to share information among multiple databases and applications. Examples of information sharing include message queuing, database replication, data warehouse loading, event notification, and even standby databases for data protection. Traditionally, vendors have provided unique solutions to satisfy the requirements of each example. However, the resulting array of technologies can become overwhelming. IT Departments find no solution meets all their needs, and fear becoming limited by the solution they have implemented should their needs change. They need a more unified approach to information sharing. Fortunately, Oracle9*i* can meet all their information sharing needs.

Oracle9*i* Streams

Oracle9*i* Streams is the key information sharing technology in Oracle9*i*. Oracle9*i* Streams enables the propagation of data, transactions and events in a data stream, either within a database, or from one database to another. Customers can use Streams to replicate data, implement message queuing and management, load changed data into data warehouses, send notifications of database events to subscribers, and provide high availability solutions to protect data.

Streams provides greater functionality and flexibility than traditional solutions for sharing information with other databases and applications. It satisfies the information sharing needs of most customers with a single integrated solution. This integrated solution allows customers to break the cycle of trading off one solution for another. They can utilize all the capabilities of Streams at the same time. Should their needs change, Oracle9*i* Streams will adapt to meet their requirements.

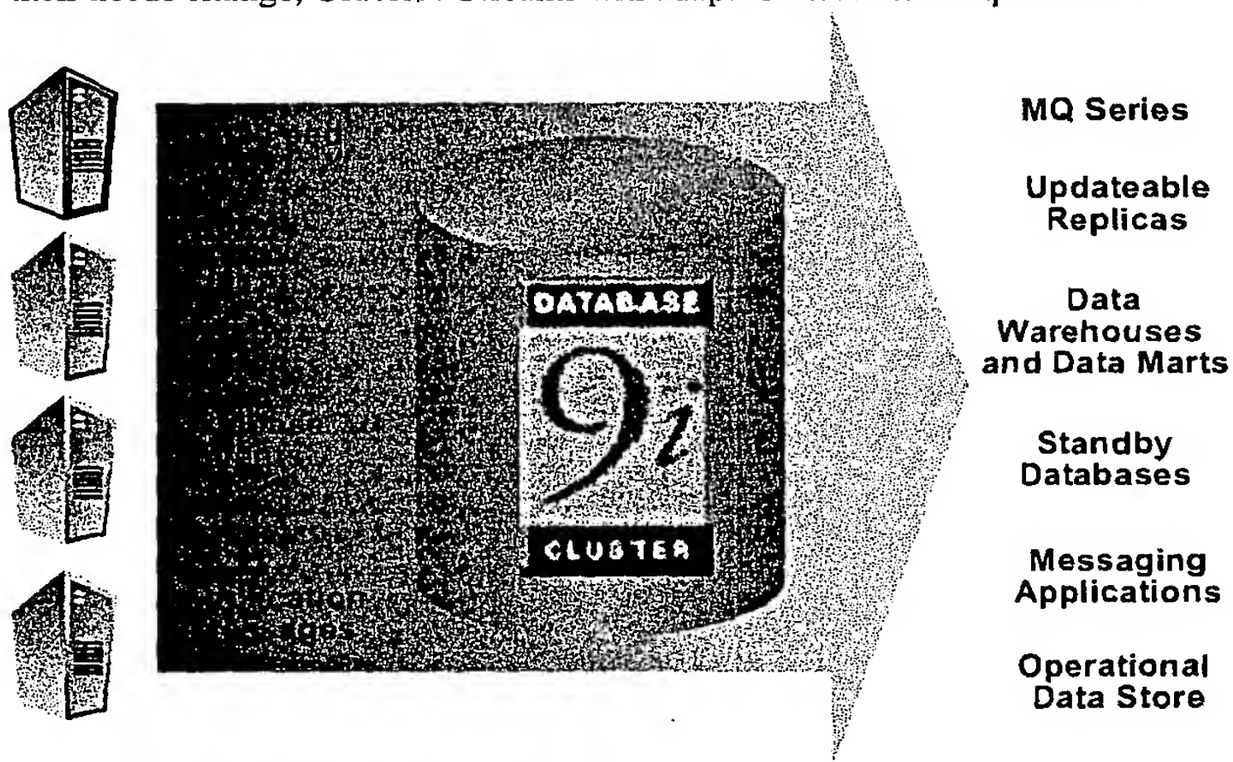


Figure: Unified Information Sharing with Oracle Streams

As shown above, Oracle Streams can be used to satisfy a great many different information sharing requirements. The sections below discuss the most common uses for Oracle Streams, message queuing and replication.

Message Queuing

Oracle Streams provides database integrated message queuing. Oracle is unique in having a unified approach to messaging and data storage. Instead of the messaging capability being only available in middleware, Oracle provides complete integration with the relational database applications and message queuing. With this functionality, messaging queuing operations can be performed similarly to that of SQL operations from the Oracle database. This unique combination has added benefits both for database users and the message queuing users. These benefits have opened new avenues of applications. Streams offers added functionality to better serve this new set of applications.

Streams' message queuing functionality enables asynchronous communication between applications/users on Oracle databases using queues. It offers multiple ways for applications to place a message in a queue called enqueue, and multiple ways for applications to get the message from a queue called dequeue. In addition it offers ways to distribute the messages to the appropriate queues called propagation. It offers guaranteed delivery of messages along with exception handling in case messages can't be delivered. It offers ways to prioritize the messages and offers time properties for messages such as expiration and delays. Notifications are also provided for immediate attention.

With Streams, message queuing operations get all the inherent benefits of a database such as reliability, integrity, high availability, security and scalability. All message queuing operations are transactional. Once committed, messages are guaranteed for delivery. Multiple message queuing and database operations can be performed in the same transaction. The database offers the disaster protection of these messages. Users of Oracle Streams can also use all the advanced security features of Oracle database.

This integration of message queuing with the database offers unique benefits. Message queuing can use all the inherent management functionality of the database. All the message queuing operations are automatically audited. All the messaging information can also be queried using a SQL view. These SQL views can be used to extract further intelligence about the messaging environment.

Message queuing can take advantages of the type system of the Oracle database. Each message can be assigned an Oracle object type. This brings structure to the messaging system, as well as better querying and content-based subscriptions. Message queuing can take advantage of new datatypes such as XMLType for XML data.

The Oracle Enterprise Manager Diagnostics and Tuning Pack supports alerts and monitoring for Streams message queues. Alerts can be sent when the number of messages for a particular subscriber exceeds a threshold. Alerts can be sent when there is an error in propagation. In addition, queues can be monitored for number of messages in ready state or number of messages per subscriber, etc.

Oracle Streams message queuing is useful for application integration, online operations of e-businesses and B2B exchanges. To address the specific needs of these applications, Streams has the following features:

- Internet Integration: Message queuing operations can be done over the Internet. Only authorized and authenticated applications/users can perform these operations.

- Transformation features: In order to aid in inter-enterprise application integration and integration of applications over the Internet, transformation functions can be defined by users to be applied at various points of communication such as enqueue, dequeue, propagation, and notification.

- Messaging gateway: In order to integrate with legacy applications, a messaging gateway automatically propagate messages to and from Streams queues to MQ Series.

Replication

Replication is the process of copying and maintaining database objects in multiple databases that make up a distributed database system. Changes applied at one site are captured and stored locally before being forwarded and applied at each of the remote locations. In addition to providing users with fast, local access to shared data, applications enjoy increased availability because alternate data access options exist. Even if one site becomes unavailable, users can continue to query or even update the remaining locations. Unlike some information sharing solutions, Oracle Streams provides platform agnostic replication, facilitating information sharing across multiple hardware platforms and database versions (Oracle9*i*R2 and later).

Replication is common in a variety of environments. For example, sales force automation, field service, retail, branch office automation and other mass deployment applications, typically require data to be periodically synchronized between central systems and very large numbers of small, remote sites often operating in a disconnected manner. While at the other end of the spectrum, applications such as call centers and Internet systems require data on multiple servers to be synchronized in a continuous, near-real time manner to ensure that the service provided is up and available at all times.

Oracle Streams can efficiently capture changes made to a system, and replicate those changes to one or more other systems. Changes are captured using Oracle Streams' log-based change capture mechanism. Changes are propagated to one or more remote databases, where they are applied using a standard apply function. The remote databases are fully open for read/write, and need not be identical copies of the source database. Because the remote database can be updated by other means, the apply mechanism will detect conflicts before changes are applied. These conflicts can also be automatically resolved using built-in or custom resolution mechanisms. Replication can be n-way. Updates at any remote database can be published and propagated to other databases on the network.

Oracle Streams also supports Oracle updateable materialized views, or snapshots, to maintain point-in-time copies of data. They can be defined to contain a full copy of a master table or a defined subset of the rows in the master table that satisfy a value-based selection criterion. Materialized views are often used to support large deployments of periodically disconnected systems, giving the users of these systems access to remote data, even when disconnected.

Other Uses for Oracle Streams

Oracle Streams can be used for much more than just message queuing and replication. Because Oracle Streams provides a unified solution to information sharing, IT departments can create solutions that previously required extensive custom development. For example, an event notification mechanism can be configured using the Streams' change capture feature, combined with its message queuing capabilities. Thus DML and DDL events can be automatically captured, and sent to subscribers via message queues.

Other Oracle features also use Oracle Streams as their underlying infrastructure. Oracle Data Guard SQL Apply extends the power of Streams by providing a complete solutions for high availability and disaster protection, including automatic failover, switchover, and management. This common infrastructure streamlines and simplifies deployments in environments that support other information sharing solutions in addition to Data Guard.

Distributed SQL

Oracle Streams is an asynchronous information sharing feature. Oracle also provides many features to support synchronous sharing of information between databases and applications, often referred to as distributed SQL. Distributed SQL allows applications to access data residing in multiple heterogeneous databases in real time, and as effortlessly as if the data were residing in a single central database. This provides obvious benefits for virtually consolidating data, while still supporting legacy applications and data stores.

Using distributed SQL, an application can simultaneously access or modify the data in several databases in a single distributed environment. Some key capabilities of distributed SQL include:

- **Database Links**: Database links enable users in one database to access objects in a remote database, without having to explicitly connect to that database.
- **Location Transparency**: Oracle9*i* supports local synonyms to reference objects that may reside in another database. Applications using these synonyms access the object as if it were local, without needing to know the objects actual destination. This allows objects to be moved as databases are migrated and consolidated, without affecting any existing applications.
- **SQL and Commit Transparency**: Oracle's distributed database architecture also provides query, update, and transaction transparency. For example, standard SQL statements such as SELECT, INSERT, UPDATE, and DELETE work just as they do in a non-distributed database environment. Additionally, applications control transactions using the standard SQL statements COMMIT, SAVEPOINT, and ROLLBACK.
- **Distributed Query Optimization**: Distributed query optimization reduces the amount of data transfer required between sites when a transaction retrieves data from remote tables referenced in a distributed SQL statement. Oracle's cost-based optimizer determines how to most efficiently process the query using local or remote resources.
- **Gateways**: Oracle Transparent Gateways and Generic Connectivity allow Oracle databases to transparently access non-Oracle database servers. When used in conjunction with distributed SQL features, remote non-Oracle objects appear as local Oracle objects.

Other Information Sharing Features

Although Oracle Streams provides unified information sharing, there are some additional information sharing features in Oracle9*i* Release 2. The most notable are Advanced Queuing and Advanced Replication. These features were introduced in prior releases of the database and were designed to meet the specific requirements of message queuing and replication users.

Oracle Streams provides much of the capabilities previously provided in Advanced Queuing. However, Oracle9*i* R2 also supports all Advanced Queuing functionality and APIs to ensure compatibility of any Advanced Queuing application. In addition Advanced Queuing is fully compatible and interoperable with Oracle Streams. Applications can propagate messages between Streams queues and Advanced Queues, ensuring applications can easily take advantage of features unique to Advanced Queuing as well as Oracle Streams.

Oracle Streams also provides most all the capabilities previously provided by Advanced Replication. However, Advanced Replication supports some features and APIs not provided by Oracle Streams, and remains an independent feature of Oracle9i. Advanced Replication also supports replication between all supported database versions, including Oracle8, Oracle8*i*, and Oracle9*i*. Advanced Replication and Oracle Streams can coexist on the same server. Thus, a DBA could replicate data using both Advanced Replication and Oracle Streams.***Internet Content Management***

Integrate and consolidate all business information

The Oracle*9i* Database stores and manages not just characters, numbers and dates, but also location information, email, documents and files, and media such as image, audio and video. In addition, the Oracle*9i* Database includes the ability to integrate an organization's existing third-party information sources through transparent gateway technology. By providing an integrated and complete solution for all business information, the Oracle*9i* Database significantly reduces the cost of storing and using all the different types of business information modern organizations have come to depend on. But more importantly, integration and consolidation of information in this manner allows an organization to easily and quickly take advantage of the synergies inherent in business information - to take full advantage of all their business information.

Business Intelligence

Significantly reduces the time it takes for a business to make better business decisions by analyzing more data faster.

The increasing need for information in business decision-making poses several formidable challenges. The use of business intelligence systems by virtually every layer of the organization has turned these systems into business-critical assets. As a result, users expect and demand faster performance and higher availability. At the same time, given the need to retain more history and greater detail, these systems are experiencing an explosion in data volumes. Data warehouse administrators have the responsibility for delivering fast performance and high availability, in the face of exponential growth.

Oracle*9i* delivers the right infrastructure to meet these challenges, an infrastructure that virtually eliminates technological limits and grows with your needs. The

Oracle9*i* Database is at the core of the Oracle Warehouse solution, delivering fast performance and simple operations for data warehouses that have more data and more users.

The Oracle*9i* database is the first complete and integrated business intelligence system that delivers not only the required performance, scalability, and manageability required to store all of an organizations' business information, but also brings a new level of integration that significantly reduces the time an organization takes to turn raw data into useful business intelligence.

The Oracle*9i* Database provides a complete suite of data storage and management capabilities, the most advanced summary and index management, and the most powerful querying and parallel capabilities of any data warehousing solution in the industry - surpassing even those provided by 'boutique' data warehousing and data mart solutions.

Handle More Data (VLDB Support)

The needs of the new business era often result in an explosion in the amount of data used for making decisions. This poses significant IT challenges. The shape of data warehouses and data marts is changing with the explosive growth in the volumes of data stored. For example, the industry average for a data warehouse is to double in size 18 months after first going live.

Maintaining these larger sets of data is a growing problem. Lowering the cost of administration of very large databases is critical in maintaining profit margins in your business. Maintenance of large data stores with table partitioning can directly affect your business costs. The purpose of data partitioning is to split large volumes of data into separate pieces or "partitions" which can be managed independently, thus lowering the total cost of ownership. A key point is that the logical data object, namely the table or index, is still just ONE object within the Oracle database. The unit of granularity of control for administration, management and availability is the partition, while the application still accesses the table as a whole. Applications can take full advantage of the performance and availability benefits that partitioning provides without any application changes being required.

Table partitioning is a key requirement for data warehousing, where large tables are commonplace. The partitioning capability of the Oracle database delivers significant improvements in the manageability, availability, and query performance of large tables and indexes. It supports Range, Hash, List and Composite partitioning for maximum flexibility. These partitioning schemes provide more choices to the data warehouse administrator in achieving the best combination of manageability and performance.

Table and index partitioning provides the following benefits:

- Smaller units of data management
- Easier placement of data on disk for improved performance
- Availability during failures or management operations
- Increased parallelism for data load, update and batch operations
- Increased performance through partition elimination and join techniques

A key point in the partitioning capability is that it is absolutely *transparent* to the application, meaning you do not modify application code to leverage the benefits of partitioning. So existing applications, or third party applications can take full

advantage of the performance improvements, the higher availability of data and increased parallelism without any modification. The partitioning is defined on the table or index, not in the application.

Other database systems have either minimal partitioning capability or it is non-existent. If hash partitioning is the only available partitioning mechanism offered, you lose out on any ability to do partitioning for administration, such as a rolling windows operation for archiving historical data in your data warehouse. Hash partitioning alone also requires rebuilding tables in case you need to change the number of partitions, add storage, re-allocate disks, etc. Oracle9*i* offers the most complete partitioning capability available today, with both partitioning for manageability as well as for performance. Oracle also offers comprehensive tool support for administering partitioning, again something other databases do not offer.

Additionally, Oracle's parallel SQL architecture increases the performance of database tasks, by dynamically subdividing these operations into distinct tasks, and distributing the workload across all processors. Oracle provides comprehensive parallel query operations, as well as parallel update operations, for optimized access of large amounts of data.

Performance in a business intelligence system is critical, because the process of investigation is repetitive, and typically involves several queries within a single session. Unless the database system can deliver fast performance for these interactive queries, it will not adequately meet the requirements of business users.
As a result of Oracle's early recognition of the significance of data warehousing, a number of specialized query processing technologies were incorporated into Oracle. This rich foundation incorporates innovative new capabilities, such as parallel bitmap star joins, and tighter integration of the technologies related to query optimization, indexing and join methods, data partitioning, and parallel execution.

In recognition of these requirements, Oracle provides the most comprehensive indexing available in the industry today. Business Intelligence applications require very fast access to data warehouse data, and bitmapped indexes are specifically designed to offer the fastest possible access for those applications. In addition, for optimal access for all applications, Oracle provides B*-tree indexes (ascending/descending), Bit-mapped indexes, Function-based indexes; Index Organized Tables, Partitioned indexes, Extensible indexes, Join indexes, Bitmapped Join indexes and Reverse-key indexes.

Oracle includes very significant technology in the area of summary management. Summaries, or aggregates, are commonly needed in decision support environments, to speed up query processing. The idea is quite simple: pre-aggregate the data at the right levels of detail, based on user needs, so that the need for processing-intensive aggregation operations can be minimized at query time. The creation of aggregates does not supplant the detail data. It simply adds another level of summarization.

Oracle9*i* provides a complete solution for the creation, use, and on-going management of summary tables, including the transparent use of summaries, through an intelligent query rewrite mechanism. This facility **automatically** redirects queries, even those issued against detail tables, to make use of existing summary tables, as appropriate, often resulting in dramatic performance improvements. This means that existing applications, such as purchased packaged applications, do not need to be changed to take advantage of the summary management capability. This is a

transparent feature to the application, so any existing application can fully exploit the functionality.

Online Analytical Processing

The spread of query, reporting, and online analytical processing (OLAP) tools through the enterprise has significantly raised analytical processing demands. Extending the data server's analytic capabilities offers many benefits, including:

- Simplified programming: less SQL code needed for many tasks.
- Reduced client processing loads: analytic computations are shifted to servers.
- Reduced network traffic load: far less detail-level data is shipped to clients.
- Opportunities for caching aggregations: similar queries can leverage existing work.

Advanced SQL analytic functions bring OLAP functionality to the relational environment

- Ranking ("Find the top 10 sales reps in each region.")
- Moving aggregates ("What is the 200-day moving average of our company's stock price?")
- Period-over-period comparisons ("What is the percentage growth of January 2002 over January 2001?")
- Ratio-to-report ("What is January's sales as a percentage of the entire year's?")
- Other functions include: Cumulative aggregates and lag/lead expressions

However, the Oracle9*i* Database goes far beyond the primary requirements of simply providing efficient storage of and access to warehoused data. To increase the efficiency and reduce the time taken to load and refresh critical data warehouses and data marts, the Oracle9*i* Database provides a complete suite of extraction, transformation and load capabilities (ETL) fully integrated into the database. For immediate, 'in-place' analysis of business data the Oracle*9i* Database also provides Oracle OLAP, a scalable, high-performance OLAP calculation engine that is also fully integrated into the Oracle9*i* Database. And the Oracle9*i* Database also includes data mining capabilities enabling any business to implement accurate, real-time recommendation capabilities into their online operations. By integrating these types of usage capabilities directly into the database, the Oracle*9i* Database significantly reduces the time it takes for organizations to extract, transform, load, store, analyze and mine their business information.

Data Mining

Data mining enhances the value of your data by finding meaningful patterns in corporate and e-business data — patterns that enable organizations to better understand and predict customer behavior. This new information can be used by other Oracle tools and applications.

Oracle has embedded data mining within the Oracle9*i* Database. All Oracle*9i* model building and scoring functions are available through a Java-based API. Oracle*9i* Database delivers a powerful infrastructure for application developers to build integrated business intelligence applications without having to off-load massive volumes of data into a separate engine to mine the data.

By delivering complete programmatic control of in-database data mining, Oracle Data Mining delivers powerful, scalable modeling and real-time scoring. This enables e-businesses to incorporate predictions and classifications in all processes and decision points throughout the business cycle.

Development Platform

Allows organizations to develop and deploy business solutions more quickly.

In recent years there has been a widely felt evolution in application development environments. Enterprises everywhere are developing Internet-based applications to take advantage of the ubiquity, affordability and the open standards of the Internet. However, developing these applications is very challenging, placing numerous additional requirements on the development platform. Choosing the right development platform is critical to ensuring the success of these applications. Oracle9*i* meets and exceeds all these requirements and is the application development platform of choice.

Today's Internet applications are fundamentally different from the client/server applications of a few years ago or even the web-based applications of the early Internet period. These applications are characterized by the fact that they are web based, accessed by a global user population, incorporate rich content and integrate with other applications using XML. In Oracle, SQL, XML and Java all interoperate seamlessly in a way that allows developers to mix-and-match the most relevant features of each language. Completeness, openness, simplicity, uniformity across data models and language API, multi-tier support – all are hallmarks of Oracle9*i*.

Incorporate Rich Content

Traditional business applications primarily dealt with relational data. Increasingly applications must also deal with documents, multi-media web content such as images, audio, video, text and graphs of complex structured objects. When it comes to storage and retrieval, you need *one uniform model* -- so you don't have to worry about object-to-relational mapping software, image files patched in from their homes in file systems, or complex document-management systems to generate PDF from tables. You need a development environment that is powerful enough to bring all the above metaphors together and make them interoperate seamlessly across programming languages, API and component models. It must provide interfaces to create, store, query and render all these datatypes. It must directly support all of these datatypes, since it is inefficient and expensive to use a separate product to deal with each complex datatype.

Oracle9*i* Database includes datatypes to handle all the types of rich Internet content such as relational data, object-relational data, XML, text, audio, video, image and spatial. To the application developer all these datatypes appear as native types in the database. They can all be queried using SQL. A single SQL statement can include data belonging to any or all of these datatypes.

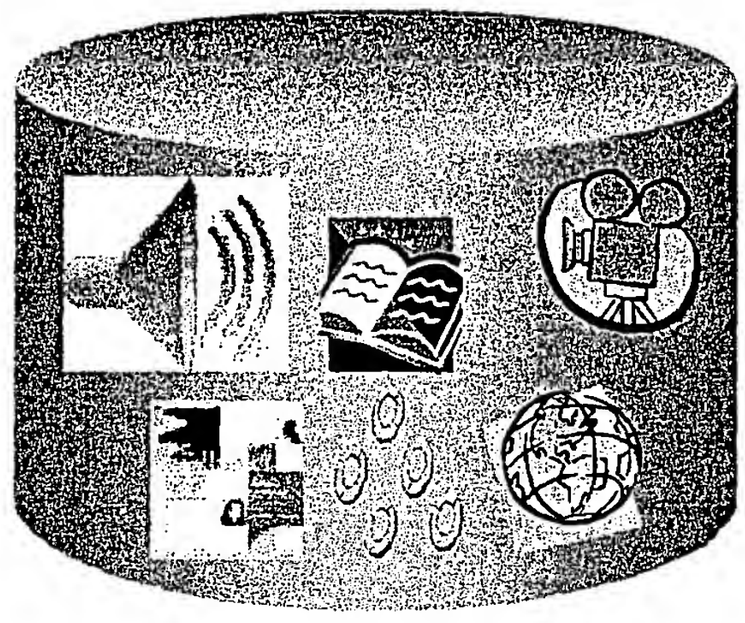


Figure: Oracle9i can manage multimedia, spatial, text and object data

Oracle9*i* lets developers create objects to model complex data that cannot be easily modeled as relational tables: objects such as Bill of Materials and Purchase Orders. In Oracle9*i* the object modeling capability has comprehensive object-oriented features including inheritance and type evolution. Java, C++ and Oracle's own PL/SQL programming language may be used to create, store and query objects in the database. Oracle offers a graphical tool—Oracle JDeveloper—to further simplify the use of objects in applications

XML Enabled

XML has emerged as the industry standard for describing business data for enterprise application integration and business-to-business commerce on the Internet. It is imperative that every Internet application be XML-enabled. XML-Enabling goes beyond being able to parse, validate or transform XML documents. XML documents represent valuable business data and should be treated as such. The application development platform must allow applications to store, query and create XML documents. It should be possible to generate XML documents from relational data as well as query and create XML documents using SQL. Since XML is a language-neutral technology, all the interfaces to manage XML must be available in all popular languages.

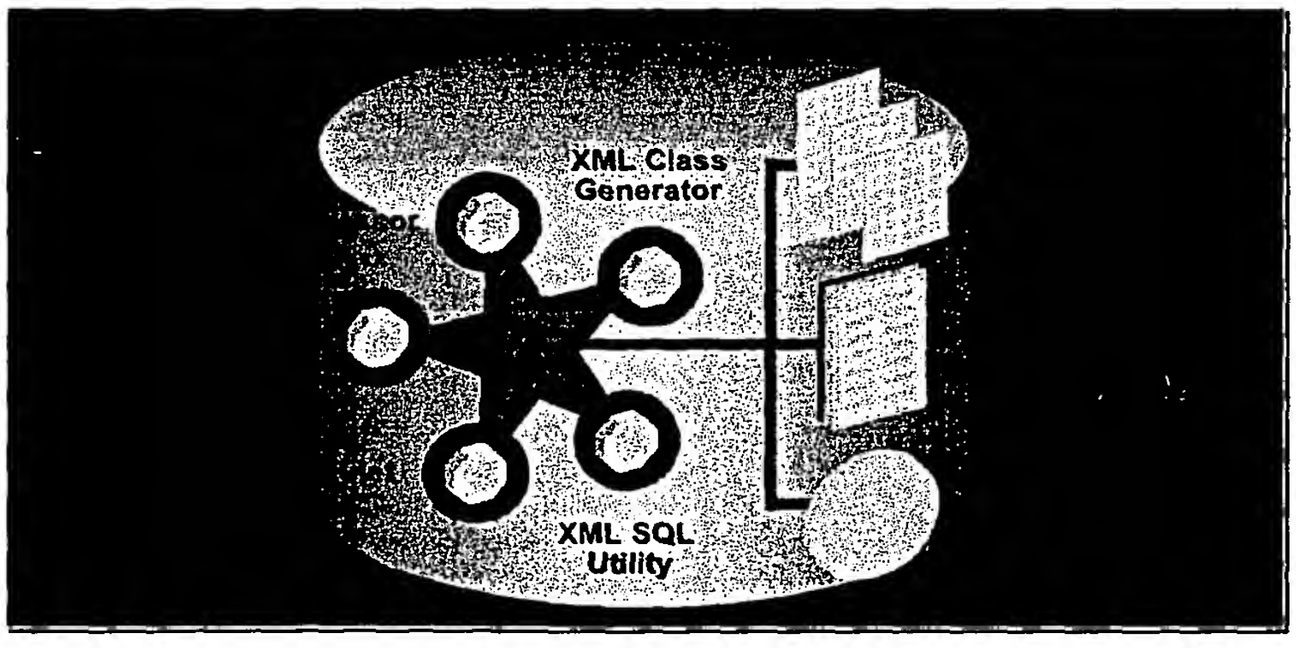


Figure: Oracle9i XML DB enables easy development of XML-enabled applications

XML DB -- CREATING, STORING AND QUERYING XML DOCUMENTS

XML DB refers to the XML capabilities of Oracle9*i*. Oracle*9i* XML DB treats XML as a native datatype in the database. XML documents stored in Oracle9*i* XML DB can be queried and retrieved using SQL, indexed for increased performance, subject to transactional control, replicated using replication and used as message payloads in the messaging system. Thus from an application developer's point of view, XML is no different from any other datatype in the database.

Oracle9*i* XML DB offers a number of easy ways to create XML documents from relational tables. The result of any SQL query can be automatically converted into an XML document. Oracle9*i* also includes a set of utilities, available in Java and C++, to simplify the task of creating XML documents.

PARSING, VIEWING AND VALIDATING XML DOCUMENTS

Oracle9*i* includes five XML Developer's Kits, or XDKs. Each consisting of a standards based set of components, tools and utilities. The XDKs are available for Java, C, C++, PL/SQL and Java Beans.
Each XDK includes a parser for parsing, validating and transforming XML documents. The parsers support both the Simple API for XML (SAX) and Document Object Model (DOM) interfaces. Oracle*9i* supports the latest DOM 2.0 and SAX 2.0 standards. The Java Beans based XDK allows XML documents to be viewed visually and allows XML documents to be incorporated into graphical applications. The XDK supports XML Schema, the latest W3C standard that adds the concept of datatypes to the XML language.

SQL and PL/SQL

SQL and PL/SQL form the core of Oracle's application development stack. Over the years, SQL has gained immense popularity in the developer community. Not only do most enterprise back-ends run SQL, but web applications accessing databases do so using SQL (wrappered by Java classes as JDBC), Enterprise Application Integration applications generate XML from SQL queries, and content-repositories are built on top of SQL tables. It is a simple, widely understood, unified data model. It is used standalone in many applications, but it is also invoked indirectly from Java (JDBC), Oracle Call Interface (dynamic SQL), XML (SML SQL Utility).

PL/SQL is Oracle's own language for development of applications and stored procedures for accessing data from the Oracle database. The name stands for Procedural Language/SQL. It is specifically optimized for use with SQL to access tables in Oracle. It is easy to use, and has a large developer community, so development skills are not hard to find. Stored packages, procedures, and triggers can all be written in PL/SQL or in Java.

Java

Oracle9*i* provides all types of JDBC drivers and enhances database access from Java applications. SQLJ allows embedding SQL statements directly in Java

code, providing greater productivity and ease of development. Java Stored Procedures are portable and secure (in terms of access control), and allow non-Java and legacy applications to transparently invoke Java.

Choice of Languages

Oracle*9i* database developers have a choice of languages for developing applications—C, C++, Java, COBOL, PL/SQL and Visual Basic. The entire functionality of the database is available in all the languages. All language-specific standards are supported. Developers can choose the languages in which they are most proficient or one that is most suitable for a specific task. For example an application might use Java on the server side to create dynamic web pages, PL/SQL to implement stored procedures in the database and C++ to implement computationally intensive logic in the middle tier.

Multi-tier Development

A new focus is in trying to develop applications to run on different tiers. If you cannot make your applications run on the mid-tier, if you cannot query your data on the application server– chances are you will have to develop-again-and-again, test everywhere. Conversely, if your database server cannot run Java, or does not understand XML natively – once again you have inflexibility.

Oracle is unique in that SQL and PL/SQL can run in both the database and the app-server tiers (in addition to XML and Java). Most people already use our development environment in the database server, where Java, SQL, PL/SQL and XML are used to manage all kinds of content.

PL/SQL Server Pages

Oracle9*i* Database supports PL/SQL Server Pages, so your application logic can be invoked directly from your web pages.

Develop for Global User Population

The Internet has provided companies the opportunity to develop applications for global audiences. The challenge in developing global applications is to support multiple languages, time zones, currencies and other location-specific information. All users located anywhere in the world have the expectation that the application was developed for their specific geographic location. Global applications allow companies to consolidate all their regional installations into a single central location, thereby reducing management costs.

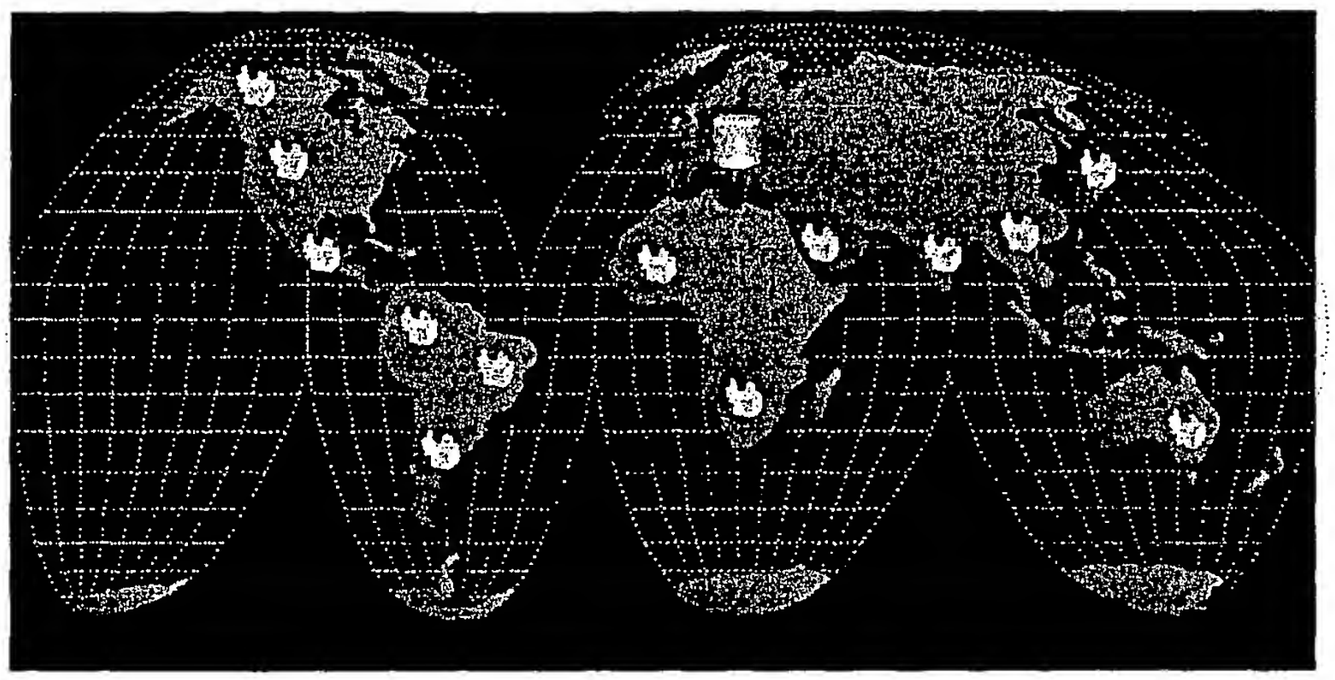


Figure: Oracle9*i* enables the development of global applications

Oracle9*i* databases can be deployed anywhere in the world. A single instance of an Oracle9*i* database can be accessed by users across the globe. Information is presented to each user in the language and format specific to his or her location.

Oracle9*i* expands support for Unicode— an international standard that specifies the character sets for all the languages in the world. Using Oracle9*i*, applications can support all languages within a single database

Complete, Integrated and Simple

Oracle9*i* not only provides all the functionality for developing Internet applications, but it also offers this functionality in a seamlessly integrated manner. With Oracle9*i* developers do not need any additional tools. They do not have to expend any effort in integrating all the technologies. Oracle9*i* is complete, integrated and therefore simple.

Oracle9*i* database developers have a choice of languages for developing applications—C, C++, Java, COBOL, PL/SQL and Visual Basic. The entire functionality of the database is available in all the languages. All language-specific standards are supported. Developers can choose the languages in which they are most proficient or one that is most suitable for a specific task. For example an application might use Java on the server side to create dynamic web pages, PL/SQL to implement stored procedures in the database and C++ to implement computationally intensive logic in the middle tier.

Faster Deployment

The Oracle9*i* Database supports more common industry standards on more open platforms than any other information management solution. Unlike other vendor solutions, the Oracle9*i* Database provides 100% support for all the standards across all the major operating system and hardware architectures available today - from Linux, to Windows, to Unix, to OS390. The superior portability of the Oracle9*i* Database empowers an organization to easily change their preferred hardware and operating system infrastructure - ensuring the right of an organization to choose the best price/performance offering from different vendors now and into the future. Any organization can leverage the Oracle9*i* Database to lower initial deployment costs and also ensure their ability to remain flexible in the future.

And as the most widely used database under all of the major packaged applications, organizations can reduce the risk involved in rapidly deploying pre-packaged business solutions as well. The Oracle9*i* Database is the number one choice of database for packaged application vendors since it provides the best platform for deployment of those applications.

Manageability

Do more for less

As organizations continue to deliver increasingly sophisticated solutions to meet new business requirements, the underlying infrastructure can quickly become more and more complex, requiring a higher degree of skilled Information Technology personnel to manage and maintain it. This coupled with ever increasing shortage of skills in this area can quickly lead to spiraling management costs and can even hinder an organizations ability to remain competitive.

The Oracle*9i* solution has been designed to address this crucial crisis. Firstly, the Oracle*9i* solution removes the complexity of having to manage many different moving parts by providing a complete and integrated solution for all infrastructure requirements that has been pre-integrated, pre-configured and proven to work. To allow the business to focus more on business differentiators, and less on managing the day-to-day operations, the Oracle*9i* Database has been enhanced to provide a higher degree of self-management - automating routine DBA tasks and reducing complexity of space, memory, and resource administration. And the Oracle Enterprise Manager product provides integrated management of all components of the complete Oracle*9i* product stack against defined business levels of service. From client to application server to database to host to network, Oracle Enterprise Manager has automated and centralized the assessment and management of a completely integrated business infrastructure, resulting in organizations being able to meet more business requirements with less cost.

As a key areas focus area for Oracle9*i*, there are five aspects to our approach taken with management:

- Make the database self managing
- Provide simple operational management of an Oracle9*i* database
- Provide tools and techniques to simplify and minimize the task time required to administer Oracle9*i*
- Enable fine-grained, automatic resource management
- Provide an end-to-end system management solution that manages the entire Oracle stack, not just the database.

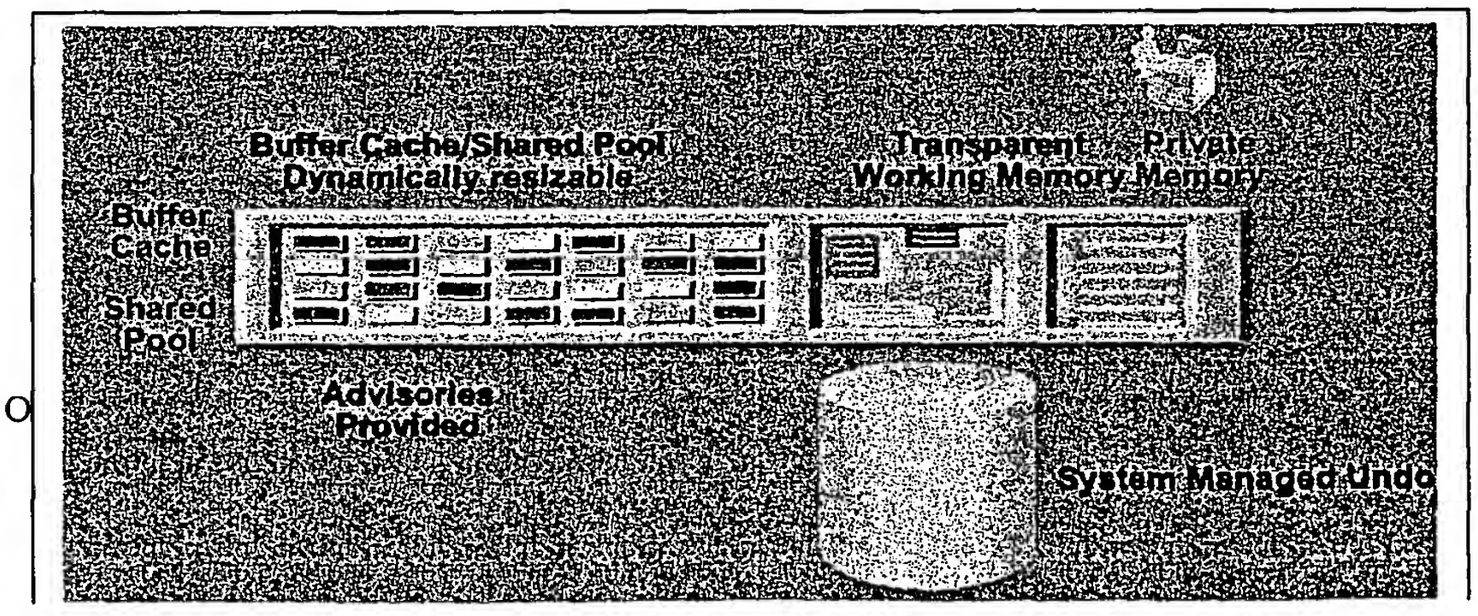


Figure: Oracle9i Self Managing Memory

Self Managing Database

Oracle's unique architecture for multi-version read consistency uses a concept called rollback segments. This is a part of the database where rollback or "undo" transactional information is maintained. As updates are made against the data in a table, Oracle automatically keeps track of the "old" information, in case the transaction does not complete successfully. Then, the system will automatically roll back the update that did not complete, thereby ensuring the transactional integrity of your data. They are also used to provide what is called a read consistent view of the data, so the data is always transactionally consistent. Oracle9*i* databases manage their own undo (Rollback) segments – database administrators do not need to plan or tune the number and sizes of rollback segments or bother about how to strategically assign transactions to a particular rollback segment. Once the administrator assigns the undo space allocation, then the database takes care of issues such as undo block contention, consistent read retention and space utilization. This frees the database administrator to do other tasks while the database manages itself.

Memory management is another area that has been given significant attention in Oracle9*i*. Traditionally, administrators have needed to shutdown the instance in order to grow or shrink the shared memory allocation for the Oracle system. Oracle9*i* provides a dynamic memory management feature that allows for re-sizing of the Oracle shared memory components dynamically. It also provides administrators with advisories to help them size the memory allocation for optimal database performance. Furthermore, Oracle9*i* provides for transparent management of working memory for SQL execution by self-tuning the initialization runtime parameters controlling allocation of private memory. This feature helps users on a system with a low number of users to reduce the time and effort required to tune memory parameters for their applications, such as Data Warehouse and Reporting applications. On systems with a higher number of users, this also allows them to avoid memory tuning for individual workloads.

Improved and Streamlined Operational Management

Oracle9*i* also includes the concept of "Oracle Managed Files" which simplify database administration by eliminating the need for administrators to directly manage the files comprising an Oracle database. Oracle9*i* internally uses standard file system interfaces to create and delete files as needed. While administrators still need to be involved in space planning and administration, this feature automates the routine task of creation and deletion of database files. Oracle9*i* also allows for better control over database downtime by enabling administrators to specify the mean time to recover (MTTR) from system failures in number of seconds. This feature, coupled with more dynamic initialization parameters, helps administrators further improve database availability. Once the administrator has set a time limit for how long a

system failure recovery can take, Oracle automatically and transparently handles making sure that the system can re-start in that time frame, regardless of the application activity running on the system at the time of the failure. This provides the fastest possible up time after a system failure.

Oracle9*i* allows for managing free space within a table via bit maps, as well as traditional dictionary based space management. The bit-mapped implementation eliminates much space-related tuning of tables, while providing improved performance during peak loads. Additionally, Oracle provides automatic extension of data files, so the files can grow (or shrink) automatically based on the amount of data in the files. This relieves the database administrator from having to manually track and reorganize the space usage in all the database files.

Oracle9*i* also supports databases created with multiple block sizes. This capability allows administrators to place objects in sets of files of appropriate block sizes in order to improve I/O performance. Those sets of files can also be transported between different Oracle databases, for example, from an OLTP environment to a Data Warehousing environment.

To ease backup and recovery operations, Recovery Manager in Oracle9*i* enables one time backup configuration, automatic management of backups and archived logs based on a user specified recovery window, restartable backups and restores, and test restore/recovery. Recovery Manager implements a recovery window, a new policy to control when backups expire. This allows administrators to establish a period of time during which it will be possible to discover logical errors and fix the affected objects by doing a database or tablespace point-in-time recovery. Recovery Manager also automatically expires backups that are no longer required to restore the database to a point-in-time within the recovery window. These features are designed to reduce the time and effort spent by administrators in performing routine backup tasks by providing for automation for most commonly performed tasks. The control file autobackup feature also allows for restoring/recovering a database even when a Recovery Manager repository is not available. Recovery Manager in Oracle9*i* also features enhanced reporting, a more user-friendly interface and the ability to specify a highly flexible backup configuration to suit varied requirements depending on the nature of database and business needs.

Oracle also provides read-only tablespaces; this enables the use of read only media for storage of data that is not being modified. It simplifies backup and recovery operations by avoiding the need to backup or restore static data.

Fine Grained, Automatic Resource Management

The Database Resource Manager provides the ability to prioritize work within the Oracle system. So high priority users get the first slice of the resources of the machine, so as to minimize response time for online workers, for example, while lower priority users, such as batch jobs or reports may take longer. This allows for more granular control over resources and provides features such as automatic consumer group switching, maximum active sessions control, query execution time estimation and undo pool quotas for consumer groups. Administrators are able to specify the maximum number of concurrently active sessions per consumer group. Once this limit is reached, the Database Resource Manager queues all subsequent requests and runs them only after existing active sessions complete.

The automatic consumer group switching feature of Oracle9*i* allows the administrator to specify a certain criteria which, if met, will cause the Database Resource Manager to automatically switch the consumer group of a long running session, for instance, from a consumer group set up for OLTP operations to one more suited for batch processing. Administrators are also able to set a maximum estimated execution time for each consumer group. The Database Resource Manager then estimates the approximate query execution time for each operation before it begins and either aborts the operation if it exceeds the limit specified, or switches the operation into a lower priority consumer group. With the Undo pool quota feature, administrators are able to specify a maximum limit on the total amount of rollback data generated per consumer group. This prevents a rogue transaction from consuming excessive rollback space and thus impacting system operation.

Management Tools And Techniques

Oracle Enterprise Manager is the cornerstone of Oracle's system management strategy. Enterprise Manager is built upon an Internet standard framework and consists of a centralized console and a set of powerful tools to provide a comprehensive systems management platform for Oracle as well as heterogeneous environments.

In Oracle9*i*, Oracle Enterprise Manager provides easy-to-use management tools that support the capabilities of the database and the entire eBusiness platform. It provides centralized database administration tools for managing both local and remote Oracle databases. Also, Oracle Enterprise Manager's graphical interface makes it simple to adopt and manage critical components such as Oracle Internet File System, Oracle Internet Directory, Oracle Internet Application Server, and Oracle Applications

Enterprise Manager key features:

- Scaleable, fault-tolerant management framework insures all management services are available 24 x7.
- Next-Generation Event Management provides powerful notification options and helps prevent problems before they occur
- 100% Java management server and console provides flexible management access
- Administrative productivity provided through knowledge sharing, task coordination, and role-based access
- Easy to use
- Help administrators maintain uninterruptible high-performance enterprise database systems

To further simplify management tasks, Oracle Enterprise Manager includes guided, expert diagnostics and problem resolution. Oracle has consolidated the wealth of expert knowledge and experience of its development and consulting teams into Oracle Enterprise Manager. Advice and recommendations about properly configuring an Oracle environment, effectively monitoring its performance, and quickly resolving problems have been incorporated directly into the Oracle Enterprise Manager management tools. For example, administrators can instantly display a set of overview charts that show the overall health of their system, with indicators that automatically alert administrators to potential problem areas. Drilldowns from these problem areas then quickly guide administrators through the

proper steps required to diagnose and resolve the problems Oracle Enterprise Manager has detected.

All essential management functions are also web based so that administrators can manage their system directly from a web browser. Oracle Enterprise Manager can also publish detailed reports to a website, allowing administrators easy access to any systems management information.

End-to-end System Management Solution

Oracle Enterprise Manager also allows administrators to go beyond monitoring the performance of single targets, like a database. Administrators are able to monitor the response of their entire Oracle based system including the Oracle9*i* Database and the Oracle9*i* Application Server, and ensure that they are meeting the required business service level agreements. This capability is critical to users such as Application Service Providers, eBusiness sites, or any business whose success depends on maintaining superior response time, performance, and availability of their IT systems. Oracle Enterprise Manager allows administrators to monitor service levels and be automatically alerted to any degradation in performance. Extensive service level reports are also available, giving a complete picture of the performance of the system.

In addition to service level reports, reporting capabilities throughout all of Oracle Enterprise Manager are extensive and extensible. A comprehensive set of pre-defined reports are included that document the configuration and health of the entire Oracle environment. Reports can be generated, for example, on the configuration of databases, the performance of applications over the last week, or the current load on the system. Customized reports can also be generated using a site's own data or by mixing-and-matching the pre-defined report topics Oracle Enterprise Manager provides. These reports can be automatically generated and posted to a website for convenient access across the organization.

Enterprise Manager also provides central user management of Oracle Internet Directory through the Enterprise Security Manager (ESM) tool. ESM allows administrators to define users in a directory and manage all their users from a centralized location. It also enables single password access to web applications, databases, and applications accounts. Built upon the Enterprise Manager framework, users can group databases into Enterprise Domains sharing a common security schema, manage roles across multiple databases, and manage schema mappings to allow multiple users to share a common schema. By centrally managing users through ESM, administrators can lower security administration costs, dramatically simplify management of user security across multiple systems, efficiently control granting or revocation of access in real-time, and scale their efforts in user management across large enterprises.

Oracle Enterprise Manager also integrates with system management framework products such as Tivoli, using industry standard technologies such as SNMP.

CONCLUSION

With the Oracle9*i* Database, Oracle offers all the features and capabilities necessary to develop, deploy, and maintain the most scalable and performing Internet-based

and traditional mission-critical applications. Oracle provides the most powerful database for secure, reliable, high capacity Internet applications, data warehouses and e-commerce web sites. It scales to support the most demanding, high throughput applications

ORACLE

Oracle9*i* Database
May 2002
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日立統合ストレージソリューション
Storeplaza

HITACHI
Inspire the Next

SAN Solution

Data Protection

障害時・災害時に効果を発揮します。

本ソリューションは、オンライン稼働中のデータベースのバックアップ取得ができる「バックアップ」と遠隔地のリモートサイトでバックアップを取得する「ディザスタリカバリ」の二つに分類されます。本バックアップをご利用になれば、オンラインを停止させる必要がなくなるため、顧客サービス提供の充実など本来の業務との両立が実現します。また、ディザスタリカバリをご利用になれば、システムの可用性が向上するとともに、災害時にもシステムを迅速に復旧できます。

【バックアップ】
(主なソフトウェア)
・JP1/Omni Back II
・VERITAS NetBackup
・VERITAS Backup Exec
・ARCserve2000

LANフリー無停止バックアップ
正ボリュームのレプリカ(副ボリューム)からバックアップ専用サーバ経由で本来のオンライン業務とは独立してバックアップを取得することが可能です。このため、24時間365日ノンストップサービスの実現など運用性が大幅に向上します。

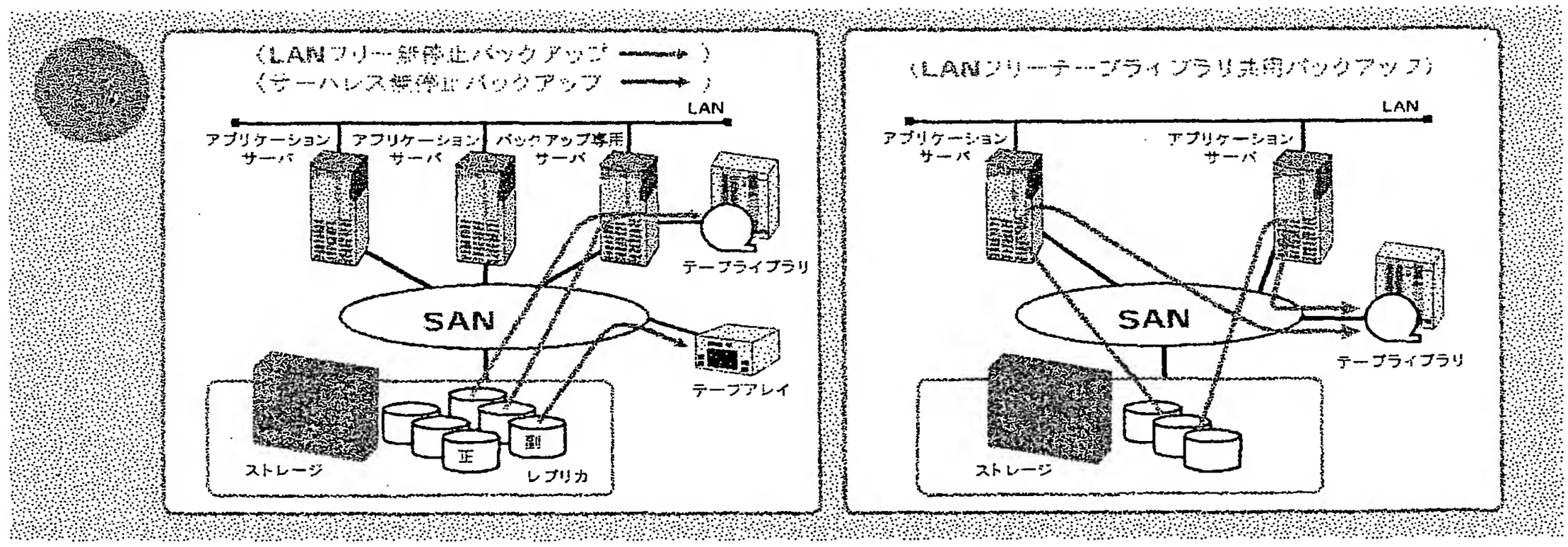
LANフリーテープライブラリ共用バックアップ
複数サーバでテープライブラリ装置を共用してバックアップの取得が可能。しかもLANを経由しないため、本来のオンライン業務を性能を落とさずに実行できます。

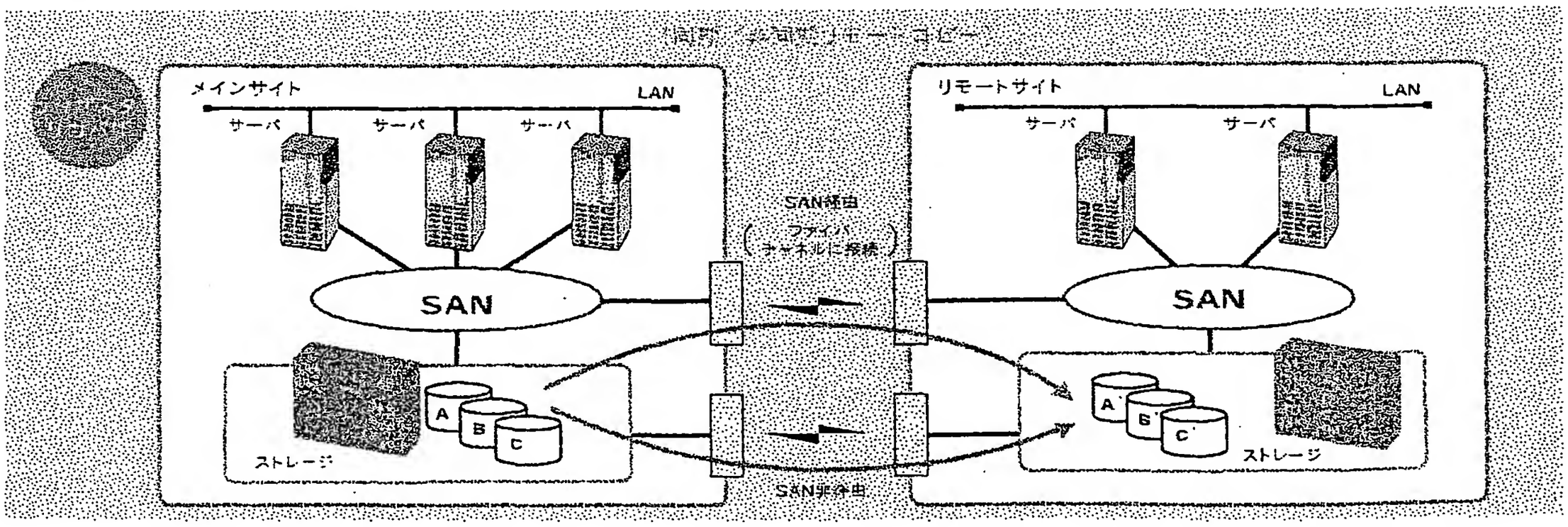
サーバレス無停止バックアップ
正ボリュームのレプリカ(副ボリューム)とテープアレイSANRISE TF350連携により、バックアップデータがサーバを経由しないため、バックアップの高速化を実現。さらに、サーバの負荷の低減もできます。

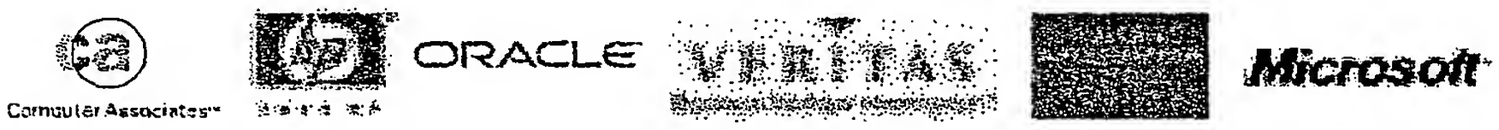
【ディザスタリカバリ】

同期リモートコピー
サーバシステム間を通信回線で接続し、メインサイトのボリュームの更新と同期してリモートサイトのボリュームへ更新データを反映します。このため、完全二重化システムが構築でき、災害時にリモートサイトで業務を続行できます。また、リモートサイトボリュームに更新差分データのみを反映させ、コピー時間を短縮させるとともに、通信コストを抑えることも可能です。さらにファイバチャネルに対応していますので、メインサイトとリモートサイトのSAN間で高速リモートコピーを実現します。

非同期リモートコピー
サーバシステム間を通信回線で接続し、随時非同期にメインサイトのボリュームからリモートサイトのボリュームへ更新データを反映します。更新データの反映に際しては、リモートサイトのサブシステムで更新データを時系列にノートし、更新順序を管理します。このため、災害時にリモートサイトで業務を実行できます。また、リモートサイトボリュームに更新差分データのみを反映させ、コピー時間を短縮させるとともに、通信コストを抑えることも可能です。さらにファイバチャネルに対応していますので、メインサイトとリモートサイトのSAN間で高速リモートコピーを実現します。







■情報提供サービス■　インターネットで「Storeplaza」の情報を提供しています。　**http://www.hitachi.co.jp/storeplaza**

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(English Translation)

HITACHI'S INTEGRATED STORAGE SOLUTION **Storeplaza**

Storeplaza, an integrated storage solution provided by Hitachi, exhibits its advantages when a failure or a disaster has occurred.

This solution provides two systems: **Backup** for obtaining a backup copy of a database running online; and **DisasterRecovery** for obtaining a backup copy at a remote site. Use of **Backup** eliminates the need for interrupting the online service, which leads to enhanced customer service. **DisasterRecovery**, on the other hand, increases the system availability, making it possible to quickly restore the system in the case of a disaster.

[**Backup**]
(Main software)
IP1/Omniback II
VERITAS Net Backup
VERITAS Backup Exec
ARC Serve 2000

LAN-free interruption-free backup
Allows obtaining a backup copy of a replica (secondary volume) of a primary volume through the backup server independently of the online service, providing considerably enhanced operability such as 24 hours and 365 days nonstop service.

LAN-free backup with shared tape library
Allows several servers to share a tape library apparatus and obtain a backup copy. Since the backup data does not go through the LAN, there is no reduction in the performance of the online service.

Server-less interruption-free backup
Uses a replica (secondary volume) of a primary volume and the tape array SANRISE TF350 in combination. The backup data does not go through the server, thereby increasing the backup speed as well as reducing the load on the server.

(English Translation)

[**DisasterRecovery**]

Synchronous remote copy
Employs an arrangement in which server systems are connected to one another by way of a communications line. An update of the data on a volume at the main site is reflected in a volume at the remote site synchronously each time the data is updated, making it possible to implement a fully duplexed system in which the remote site can take over the application processing in the case of a disaster. It can be arranged that only the updated data portion is reflected in a volume at the remote site to reduce the time for copying and the communication cost. Furthermore, fiber channels are supported to perform high-speed remote copy operation between the SANs of the main site and the remote site.

Asynchronous remote copy
Employs an arrangement in which server systems are connected to one another by way of a communications line. Each update of the data on a volume at the main site is asynchronously reflected in a volume at the remote site as necessary; the updated data is chronologically sorted by a subsystem at the remote site to control the reflection order of each update. This allows the remote site to take over the application processing in the case of a disaster. It can be arranged that only the updated data portion is reflected in a volume at the remote site to reduce the time for copying and the communication cost. Furthermore, fiber channels are supported to perform high-speed remote copy operation between the SANs of the main site and the remote site.

(English translatim)